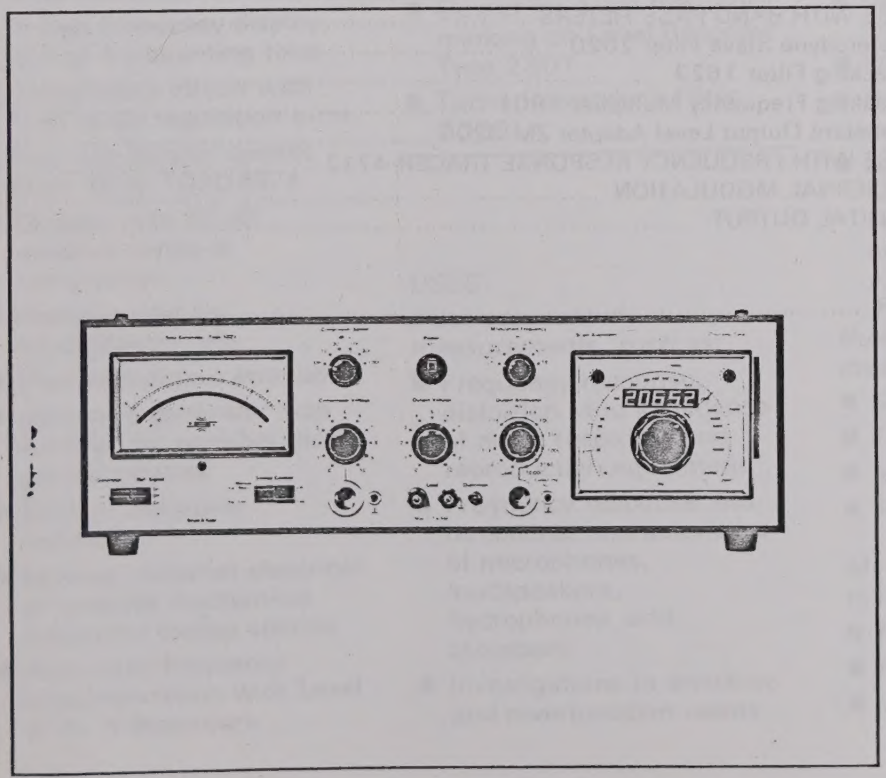
Instruction Manual 1023

Sine Generator Type 1023



A precision sine generator covering the 10 Hz — 20 kHz range with a single logarithmic or linear sweep. Generator frequency may be controlled manually, or externally via a mechanical drive or voltage ramp. Has built-in compressor with 60 dB dynamic range, output attenuator covering a 100 dB range, and a low distortion 7 W output amplifier. Frequency modulation of generator may be activated internally, or controlled by an external voltage. A five digit frequency display and provision for frequency marking of Level Recorder paper is included. High frequency tuning signals for Heterodyne Slave Filter Type 2020 are also provided.

033-0113

B K Brüel & Kjær

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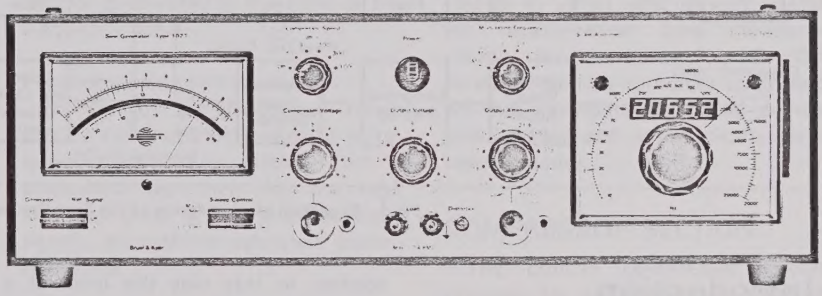
type 1023

Sine Generator



FEATURES:

- Frequency coverage 10 Hz to 20 kHz in one range
- Lin and Log frequency scales
- High stability, voltage controlled oscillator
- Built-in frequency modulator
- Low distortion
- 5 digit frequency display, 0,1 or 1 s counting time
- Compressor circuit with 0 dB static regulation error
- Five compressor speeds from 10 to 1000 dB/s
- Greater than 60 dB dynamic range of compressor
- Power output for loudspeakers, etc.
- Precision output attenuator
- Noiseless generator stop function for reverberation measurements
- Built-in electronic voltmeter
- Manual, external electrical or external mechanical frequency sweep control
- Automatic frequency synchronization with Level or X—Y Recorders
- Output for exact frequency marking on Level Recorder Type 2307
- Tunes Heterodyne Filter 2020

USES:

Electroacoustical measurements, such as:

- Frequency response, distortion, and impedance of audio recording and reproduction equipment
- Frequency response and directional characteristics of microphones, loudspeakers, hydrophones, and projectors
- Investigations in anechoic and reverberation rooms
- Determination of audio filter characteristics
- Phase response
- Hearing aid frequency response calibration
- Automatic recording of harmonics with Tracking Frequency Multiplier 1901 and Filter 2020 or Analyzer 2010

Building Acoustical measurements, such as:

- Sound distribution
- Transmission loss
- Sound insulation
- Reverberation time

Mechanical Dynamics measurements, such as:

- Mechanical impedance
- Phase
- Vibration testing

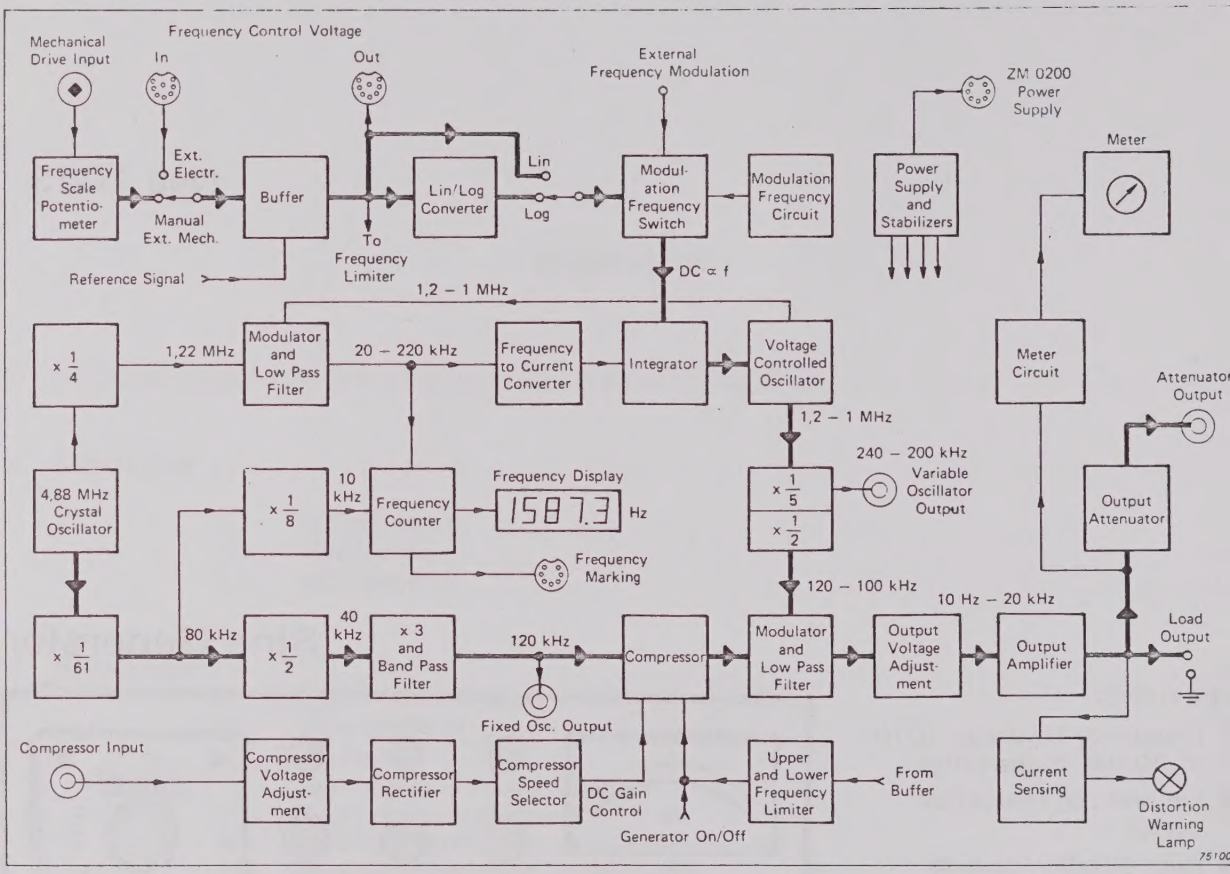


Fig.1. Simplified block diagram of the Sine Generator

Introduction

The Sine Generator Type 1023 is a precision signal generator which covers 10 Hz to 20 kHz in one continuous range. Frequency modulation of the output signal is available. This is often used to prevent the generation of standing waves in building acoustic measurements.

In addition to the analogue frequency scale the instrument is equipped with an accurate frequency counter with a five digit frequency display. The 1023 can be swept both linearly and logarithmically, and scanning of the entire frequency range can be made manually, or remotely via a mechanical drive or an electrical signal. Hence, the Generator can be synchronized with a Level or X—Y Recorder to obtain a graphic record of the measurement result.

A major feature of the Sine Generator is the built-in compressor circuit which allows the output voltage to be controlled from an external source. In this way the level at a test object can be maintained constant when the frequency is swept, even if the load varies, as is the case with loudspeakers and vibration exciters for example. The compressor gives no regulation error for fixed frequency outputs, regardless of the degree of compression.

The built-in voltmeter is furnished with linear and dB scales, and indicates the voltage at either the attenuator output or the load output. 0,1 mV to 10 V RMS full scale is available at the attenuator output. The load output can supply 0 to 10 V RMS at 700 mA RMS which gives a max. output power of 7 W. This is enough to drive, for example, a Standing Wave Apparatus Type 4002, a Hearing Aid Test Box Type 4212, an Artificial Voice Type 4219, or a Mini-Shaker Type 4810.

The 1023 can tune the Heterodyne Slave Filter Type 2020 so that constant-bandwidth analyses can be performed. Automatic harmonic analyses can be made when the Tracking Frequency Multiplier Type 190 is included in the set-up.

For production testing and inspection of amplifiers, tape recorders, filters loudspeakers and other electroacoustic devices, the 1023 can sweep automatically with an Audio Frequency Response Tracer Type 4712.

Description

The Sine Generator Type 1023 is a beat frequency oscillator which operates on the heterodyne principle using two high-frequency oscillators. One of these generates a fixed frequency while the frequency of the other can be varied continuously. The two signals are mixed in a modulator and the difference frequency is filtered through a low pass filter whereby a variable low frequency sinusoidal signal is obtained. The advantages of this principle compared with RC and function generators are its high frequency and amplitude-stability and its abi

ity to sweep continuously over a wide frequency range. In addition, the technique permits control of slave filters in exact synchronization with the output frequency. Fig.1 shows a simplified block diagram of Type 1023; the heavy lines indicate how the output signal is produced.

GENERATOR SECTION

High Frequency Oscillators

The fixed frequency oscillator is crystal controlled giving high stability. The various frequencies used in different parts of the instrument are derived from it via frequency converters. One of these signals, 120 kHz, is fed through the regulating compressor amplifier to a modulator and low pass filter where it is mixed with the voltage controlled oscillator (VCO) signal.

The frequency of the VCO is controlled by a DC voltage, which is supplied either from a high precision, low noise, conductive plastic potentiometer connected to the shaft of the frequency scale dial or from an external source for remote control. The DC voltage is used to perform a linear sweep while a logarithmic sweep is obtained by transforming the linear voltage ramp into a logarithmic characteristic in the built-in Lin-to-Log converter.

Frequency Modulation

The Sine Generator features a sawtooth oscillator for frequency modulation of the output signal. The internal mudulation frequencies of 1; 2,5; 6,3 and 16 Hz have a swing of ± 10% of the centre frequency up to 2,5 kHz, above which the frequency deviation is a constant ± 250 Hz. External modulation or a fixed frequency offset is achieved by connection of an appropriate DC voltage to the instrument.

Sweep Control

A friction clutch permits both manual and external mechanical sweep control; electrical sweep control is also provided for. This permits easy synchronization with a Level Recorder Type 2307 or 2309, or an X—Y Recorder such as Type 2308. The sweep can be either linear or true logarithmic from 10 Hz to 20 kHz.

The logarithmic sweep is normally used for frequency response measurements and in connection with constant percentage bandwidth filters, where it gives a uniform resolution. A linear sweep is preferred for phase response measurements on loudspeakers as the slope gives information about the group delay. The linear sweep is also used together with constant-bandwidth filters, since it then gives equal separation and resolution of harmonically related components. This is very useful for discovering harmonic relationships. It also allows minimum analysis time when used with a constant bandwidth slave filter such as Type 2020.

A 50:1 reduction gear is coupled to the shaft of the frequency scale dial to permit fine frequency adjustment of the output frequency. The control is situated to the right of the frequency scale.

Frequency Range Adjustment

If desired, the frequency range can be narrowed by means of a frequency comparator circuit. This is controlled separately for the high and low ends of the scale by rear-panel, screwdriver-operated potentiometers.

Digital Frequency Display

A counter circuit measures the frequency of the VCO signal, and the five digit frequency display is calibrated to read the output frequency of the generator. The counting time is selectable to be either 0,1 or 1 second. 0,1 s gives 10 frequency readings per second with a resolution of 1 Hz. The 1 s counting time gives one reading per second with a 0,1 Hz resolution up to about 9000 Hz. Above this frequency the counting time automatically switches to 0,1 s to prevent display overflow.

A special output from the counter is available for controlling the event marker on a connected level recorder. When uncalibrated chart paper is used with a linear sweep of the generator, for example, this facility ensures exact frequency calibration of the chart. The frequency marking is switchable to mark for shift of digit 2, 3 or 4 of the frequency display.

Reference Signal

A toggle switch with positions "On", "Off", and "On" with self return, can provide a reference frequency of approx. 1000 Hz independent of the generator frequency setting. This is useful when automatic recordings are being made as it checks whether the pen deflection of the Level Recorder will be on scale at the middle frequencies where the highest amplitudes are most often found. It may also be used for easy recording of the reference signal preceeding frequency recordings to be used in conjunction with the Response Test Unit Type 4416.

Generator On/Off

The generator output can be shut down with a toggle switch which has the positions "Off", "On", and "Off" with self return. It suppresses the output signal more than 70 dB (60 dB in 2 ms), and is very useful for reverberation time measurements, for example. The On/Off function can be remotely controlled so that reverberation dacay curves can be recorded automatically on a level recorder.

COMPRESSOR SECTION

The built-in compressor circuit provides for automatic regulation of the output level over a dynamic range of more than 60 dB. The compressor is of such a design that when dwelling at a single frequency the level regulation will be error-free regardless of the degree of compression. There are five compressor speeds to choose from: 10, 30, 100, 300, and 1000 dB/s, and the amount of compression is continuously adjustable.

OUTPUT SECTION

The signal from the output amplifier is available at two different output terminals.

Attenuator Output

Voltages between 100 μV and 10 V RMS for full meter deflection are available from this terminal. The output signal may be attenuated by up to 100 dB in accurate 10 dB steps, and the level is continuously variable within each step. All attenuator positions have an output impedance of 50 Ω.

Load Output

This terminal is a direct output from the amplifier. It has an output impedance of less than 0,2 Ω and the output level is continuously variable between 0 and 10 V RMS. With the Output Attenuator in position "Load", this output can provide a maximum current of 700 mA RMS which means 7 W into a 14,3 Ω load impedance. In the other attenuator positions the Load output is still available, but the maximum current is reduced by approximately 50 mA. A current sensing circuit lights the Distortion warning lamp when the current drawn from the output amplifier exceeds 700 mA.

METER SECTION

The meter circuit uses an average detector calibrated to read the true RMS value of sinusoidal signals. The precision meter is equipped with a mirrored scale to prevent parallax errors. It indicates the unloaded output voltage of the generator in all the 50 Ω positions of the Output Attenuator. This is often called the electromotive force. In the Load position, 10 V RMS corresponds to full scale deflection and the influence of loading is seen on the meter.

Examples of Use

Fig.2 suggests a number of possible instrument set-ups for the wide range of applications of the Sine Generator Type 1023.

Frequency Response

In the basic set-up, the sweep of the Sine Generator Type 1023 is controlled by the Level ~~or~~ X—Y Recorder and the resulting frequency response curve is automatically plotted on the preprinted level recorder paper (Fig.3).

The linear frequency sweep also available from the 1023 is especially of use when measuring on circuits, such as very sharp filters, whose characteristics cannot be displayed accurately on a normal logarithmic scale. The linear sweep can then provide a significant expansion of the scale giving greater resolution and accuracy, while still maintaining frequency calibration of the recorder paper via the frequency marking facility (Fig.4).

The compressor section of the 1023 permits a variety of frequency dependent measurements where a given parameter must be held constant. It is used, for example, when it is desired to generate a constant sound pressure necessary for microphone frequency response measurements, for keeping the vibration level of a vibration exciter constant, or for generating a constant current necessary for impedance measurements.

For frequency response measurements where the signal-to-noise ratio is poor, a band-pass filter synchronized in frequency with the 1023 may be included in the measuring circuit or the compressor loop or both. The Type 2020 Heterodyne Slave Filter is synchronized by means of high frequency tuning signals from the 1023 and provides a range of four narrow constant-bandwidths (3 to 100 Hz), mainly for linear frequency sweeping. The Type 1623 Tracking Filter can track the

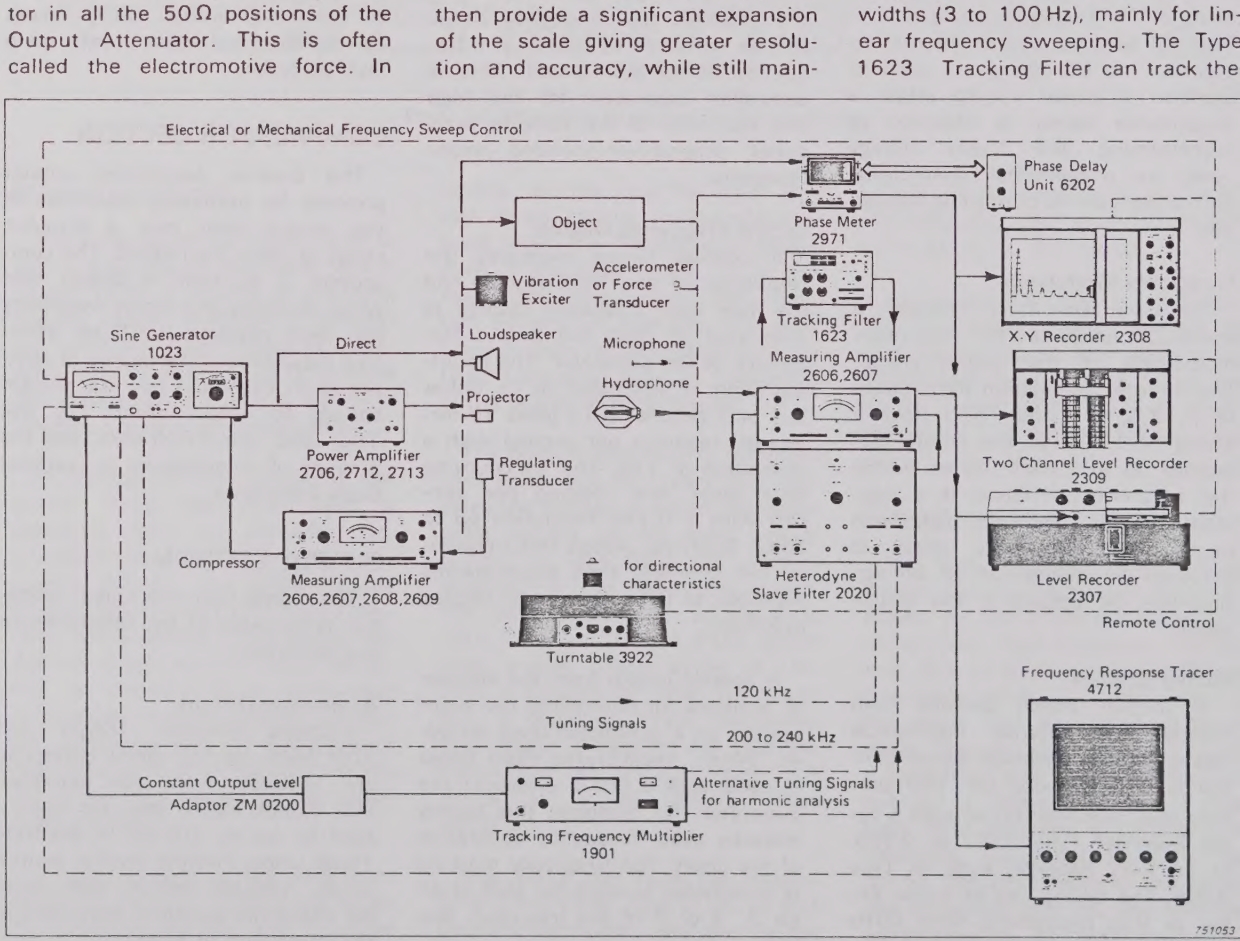


Fig.2. Some practical measuring set-ups for a wide range of application

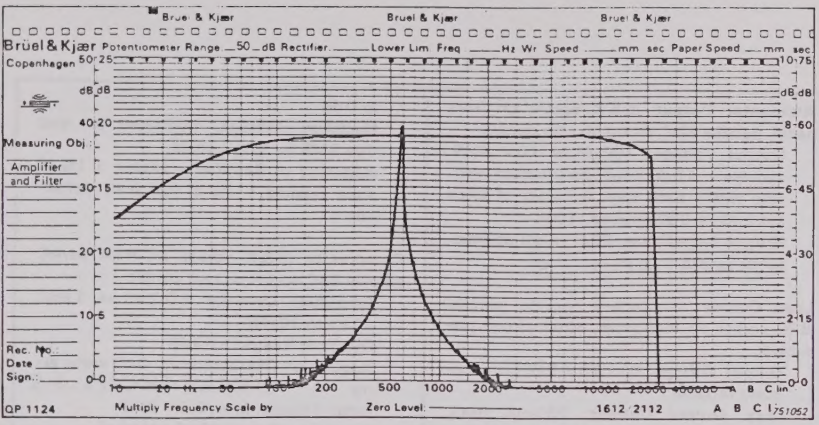


Fig. 3. Frequency response of an audio amplifier and a narrow band filter

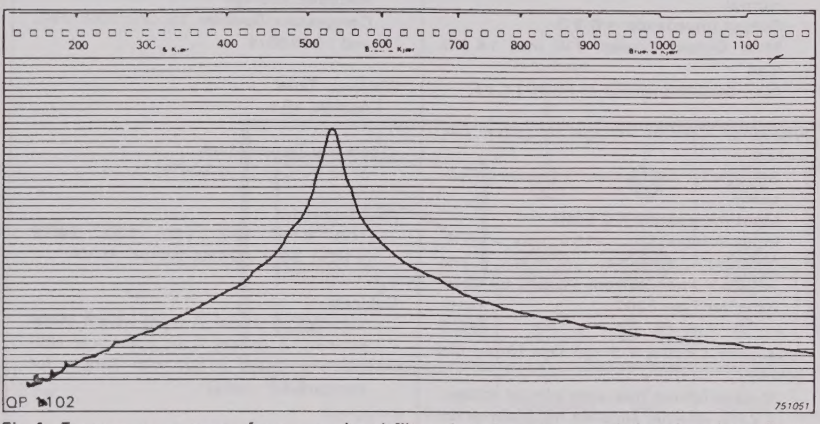


Fig. 4. Frequency response of a narrow band filter plotted on an expanded scale using a linear sweep

1023 output directly and provides a range of three constant-percentage bandwidths (6%, 12% and 23%), mainly for logarithmic frequency sweeping.

Distortion

The Heterodyne Slave Filter Type 2020 may also be used for measurements of total harmonic distortion. By operating the 2020 in the rejection mode, a sharp band-stop filter automatically follows the generator frequency in precise synchronization.

For the measurement of individual harmonic distortion, the Heterodyne Slave Filter Type 2020 is also used, but in the bandpass mode. In addition, a Tracking Frequency Multiplier Type 1901 is required to multiply the output frequency of the 1023 by an appropriate factor (selectable in steps of 0,1 from 0,1 to 99,9) to tune the 2020 to the desired harmonic. The distortion curves are then automatically plotted on the Level Recorder.

Reverberation Time

The frequency modulation feature of the 1023 makes it well-suited for measurements of reverberation time. The warble tone generated has a wider frequency spectrum than a pure sine, and hence reduces problems caused by standing waves. The resulting decay curves are displayed on the Level Recorder, and the reverberation time is derived based on the slope of the curve.

Phase

The linear sweep feature of the 1023 is also of use for loudspeaker phase response measurements in conjunction with a Phase Meter Type 2971 and Phase Delay Unit Type 6202. The linear sweep simplifies interpretation of the curves and permits easy calculation of the relative group delay of the various drivers of the loudspeaker system. The Phase Meter may also be used for phase measurements on amplifiers and for plotting the imaginary component of impedance.

Other applications

The output level controls permit adjustments of signal levels from 10 μV to 10 V. This permits frequency response, distortion, and phase measurements of high gain circuits without the need for adding additional external attenuation. At the same time, the output power amplifier of the 1023 provides adequate power to drive a loudspeaker or small shaker table. However, this wide range of output levels may be too great to permit operation with certain other instruments which require a trigger signal, such as the Motion Analyzer Type 4911, Frequency Response Tracer Type 4712, or Tracking Frequency Multiplier Type 1901. When this is the case, a Constant Output Level Adaptor ZM 0200 is available. This adaptor provides a constant output level of approximately 1 V RMS which is suitable for triggering these instruments.

Specifications 1023

Output Waveform:
Sinusoidal

Frequency Range:
10 Hz to 20 kHz in one continuous range, switchable linear or logarithmic

Frequency Range Adjustment:
Upper and lower frequency limit adjustable by rear-panel screwdriver-operated potentiometers

Frequency Stability:
Measured over 8 hours after 1 hour warm-up time
Lin. Scale: 0,1% + 1,5 Hz
Log. Scale: 0,2% + 1,5 Hz

Amplitude Linearity:
± 0,2 dB re 1 kHz, 10 Hz to 20 kHz

Signal-to-Noise Ratio:
> 70 dB

Distortion (each harmonic):
Attenuator Output:
< 0,1% 20 Hz to 20 kHz
< 0,15% 10 Hz to 20 kHz
Load Output, loaded 7 W:
< 0,15% 10 Hz to 20 kHz

Frequency Scale:
Linear and logarithmic scales
Accuracy:
Lin: ± 1% of tuned frequency
Log: ± 3% of tuned frequency

Frequency Counter:

Five digit 7-segment display

Counting Time: 0,1 s and 1 s, switch selectable. Automatic shift to 0,1 s above approx. 9 kHz. Automatic decimal point setting

Accuracy: ±1 on last digit ±20 ppm of tuning frequency (± 1Hz and ± 0,1 Hz at counting times 0,1 s and 1 s respectively)

Frequency Control:

Manual coarse and fine adjustment over entire frequency range, 1:50 ratio for fine

External Mechanical via flexible shaft or chain drive, for example from Level Recorder Type 2307

33 rotations for full scale Log sweep, 30 for full scale Lin sweep

External Voltage from linear DC source, for example X—Y Recorder Type 2308, or from linear chart position potentiometer, for example Level Recorder Type 2307 or 2309. Full scale sweep: **Lin** 0 to 10 V DC, 2 Hz/mV. **Log** —1 to +10 V DC, 0,3 decade/V corresponding to 1 octave/V

Voltage to Frequency Conversion: Linearity 0,03% (lin scale)

Operation with Frequency Response Tracer Type 4712: Built-in sweep unit for direct connection to the 4712 (8-pin DIN socket "Frequency Control Voltage In")

Frequency Marking (7-pin DIN socket):

Output for controlling event marker on Type 2307 Level Recorder for exact chart calibration. Switchable to mark shift of digit 2, 3 or 4

Frequency Modulation:

Modulation Swing: ± 10% of tuned frequency up to max. ± 250 Hz

Modulation Frequency: 1; 2,5; 6,3; and 16 Hz, switch selectable. Provision for external modulation (8-pin DIN socket "Frequency Control Voltage In", 0,2 Hz/mV)

Generator On/Off:

Three position toggle switch, "Off", "On", and "Off" with self return. Suppresses the output signal more than 70 dB, 60 dB in approx. 2 ms

Noiseless. May be remotely controlled (7-pin DIN socket "ZM 0200 Power Supply")

Reference Signal:

Three position toggle switch, "On", "Off", and "On" with self return

Reference Frequency: 1000 Hz ± 3%, level is controlled by "Output Attenuator" and "Output Voltage" knobs

Attenuator Output: (B & K socket on front panel, parallel BNC socket on rear panel):

Output Voltage: 100 μV to 10 V RMS, variable in 10 dB steps, continuously variable within each step. Accuracy of steps ± 0,2 dB re 0 dB position (10 V)

Output Impedance: 50 Ω in all attenuator positions

Load Output (two banana sockets, parallel BNC socket on rear panel, short circuit protected):

Output Voltage: 0 to 10 V RMS continuously variable

Max. Output Current: 700 mA RMS, "Distortion" lamp lights for higher output current

Output Impedance: < 0,2 Ω

Max. Output Power: 7 W into 14,3 Ω load

Min. Load Impedance at FSD: 14,3 Ω

Frequency Control Voltage In (8-pin DIN socket)

Sensitivity: See under "Frequency Control"

Input Impedance: > 0,5 MΩ

Input Voltage: Min. —15 V, max. + 15 V

Voltages available: + 15,4 V and —1,35 V (max. current 10 mA) for Level Recorder Type 2307

Frequency Control Voltage Out (8-pin DIN socket):

Voltage follows frequency control voltage ± 2 mV whether supplied internally or externally

Output Impedance: < 1 Ω

Min. Load Impedance: 10 kΩ

Fixed Oscillator Output (BNC socket):

120 kHz sine wave, 150 mV RMS

Min. Load Impedance: 10 kΩ//300 pF

Variable Oscillator Output (BNC socket):

240 to 200 kHz unsymmetrical square wave, TTL output, 2,4 to 5 V peak-to-peak

Min. Load Impedance: 5 kΩ//300 pF

ZM 0200 Power Supply (7-pin DIN socket):

Supplies power to the optional Constant Output Level Adaptor ZM 0200. Contains also facility for remote control of "Generator On/Off" function

Voltages Available: ± 15,4 V (max. 50 mA) and + 5 V (max. 100 mA)

Voltmeter:

Electronic voltmeter with large, accurate taught-band instrument including mirrored scale. Indicates EMF (electromotive force) in attenuator positions and output voltage in position "Load"

Scales: 0 to 10 V, 0 to 3,16 V and —20 to 0 dB

Rectifier: Average, calibrated to read true RMS for sine signals

Accuracy of Rectifier + Meter: ± 1% of scale reading ± 1% of full scale deflection

Compressor (B & K socket on front panel, parallel BNC socket on rear panel):

Amplitude Linearity: ± 0,2 dB re 1 kHz, 10 Hz to 20 kHz

Dynamic Range: > 60 dB

Regulation Characteristic: 0 dB static error

Input Voltage: Min. 0,5 V RMS

Input Impedance: 25 kΩ//100 pF

Rectifier: Average

Compressor Speeds: 10, 30, 100, 300, and 1000 dB/s

Warm-up Time:

Approx. 15 s

Operating Temperature:

5° to 40°C (41° to 104°F)

Power Supply:

100, 115, 127, 150, 220, 240 V (± 10%); 50 to 400 Hz; approx. 40 VA

Cabinet:

Supplied as model A (light-weight metal cabinet), B (model A in mahogany cabinet), or C (as A but with flanges for standard 19" racks)

Dimensions (model A):

(Excluding feet, knobs, etc)

Height: 133 mm (5,2 in)

Width: 430 mm (16,9 in)

Depth: 200 mm (7,9 in)

Weight (model A):

7,4 kg (16,3 lb)

Accessories Included:

2 B & K Coaxial Plugs JP 0101
2 BNC Coaxial Plugs JP 0035
2 7-pin DIN Plugs JP 0703
2 8-pin DIN Plugs JP 0802
1 Flexible Shaft UB 0041
1 Power Cable AN 0010
Spare fuses and lamps

Additional Accessory for Model C:

1 Chain Drive Sprocket UT 0024

Acessories Available:

Constant Output Level Adaptor ZM 0200 (provides approx. 1 V RMS sine wave with same frequency as generator output. Distortion < 1%. S/N ratio > 40 dB. Min. load impedance 10 kΩ//1 nF)

Frequency Control Cable AQ 0034 (for use with Level Recorder Type 2307)

2. CONTROLS

2.1. FRONT PANEL

Amplitude Related Controls:

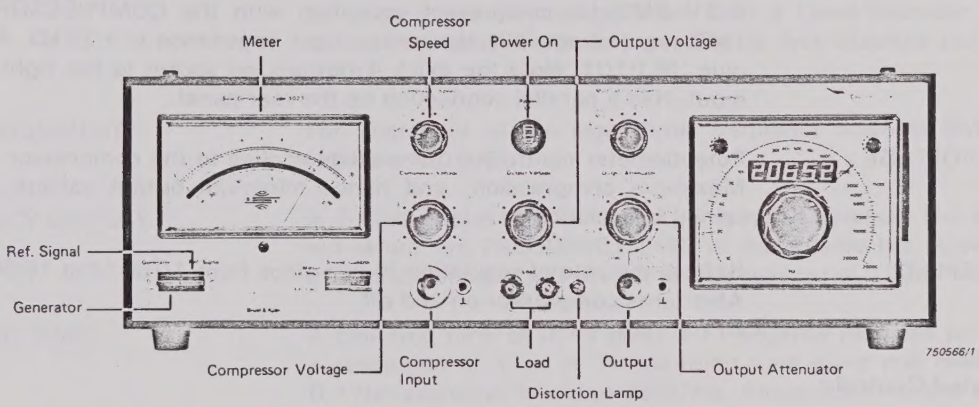


Fig.2.1. Amplitude related controls of 1023

POWER ON: Power is on with the switch in the up position. Warm up time for normal use is less than 5 seconds. If very high stability is required, a longer warm up is required.

GENERATOR: Three position switch for noiseless cut-off of generator output. The down position is spring loaded.

REF. SIGNAL: Three position switch for reference signal at approximately 1000 Hz ("On" positions). In "Off" the frequency is determined by the FREQUENCY DIAL setting. The down position is spring loaded.

OUTPUT ATTENUATOR: A precision attenuator for adjusting the output voltage at the OUTPUT socket in 10 dB steps over a 100 dB range. Each position indicates the output voltage (in mV) corresponding to full scale deflection on the built-in meter. The "Load" position removes the signal from the OUTPUT socket and switches the METER to monitor the output voltage at the LOAD socket. The attenuator does not influence the voltage appearing at the LOAD socket.

OUTPUT VOLTAGE: Potentiometer controlling the output voltage at both the LOAD and OUTPUT sockets.

LOAD: Output sockets from the 7 W power amplifier giving a maximum output voltage of 10 V RMS and 0,7 A. Accepts standard 4 mm banana plugs.

If the output current exceeds 0,7 A the DISTORTION lamp lights. The direct (DC) coupled output is short circuit protected. Has a parallel output on the rear panel.

OUTPUT: Standard B & K coaxial socket giving generator output as determined by the OUTPUT ATTENUATOR. Note the extra ground socket to the right of the OUTPUT socket. Has parallel connection on the rear panel.

METER: Indicates the unloaded output voltage of the generator in all 50 Ω positions of the OUTPUT ATTENUATOR. In the "Load" position, 10 V RMS corresponds to full scale deflection and the influence of loading is seen on the meter.

COMPRESSOR INPUT: Input socket for compressor control signal. Minimum input voltage is 0,5 V RMS for compressor activation with the COMPRESSOR VOLTAGE control set fully clockwise. Input impedance is > 25 kΩ. Accepts plug JP 0101. Note the extra 4 mm ground socket to the right of the input. Has a parallel connection on the rear panel.

COMPRESSOR VOLTAGE: Potentiometer controlling the voltage applied to the compressor circuit. Maximum compression, and hence minimum output voltage, is obtained fully clockwise.

COMPRESSOR SPEED: Selects the rate of regulation in five steps from 10 dB/s to 1000 dB/s. Also turns compressor on and off.

Frequency Related Controls:

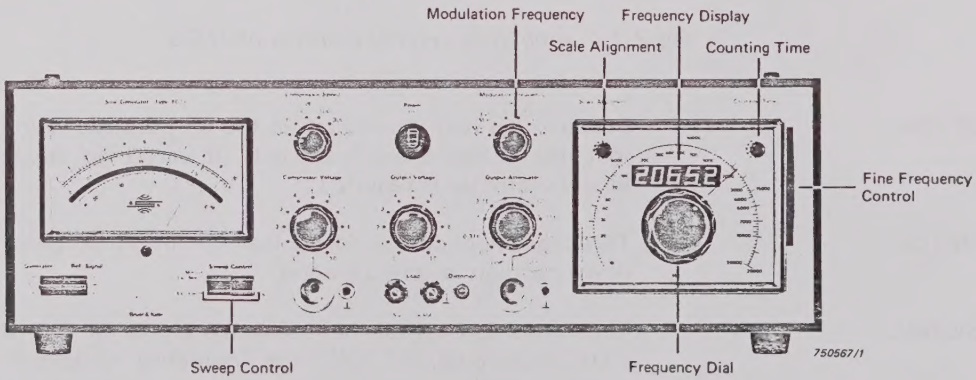


Fig. 2.2. Frequency related controls of 1023

SWEEP CONTROL: Two switches. The left-hand switch selects sweep source:

"Manual Ext. Mech.": Generator frequency is controlled by position of FREQUENCY DIAL which may be moved manually or by an external mechanical drive connected to the sockets on either side of the instrument. A friction clutch permits manual frequency control even with an external drive connected.

"Ext. Electr.": Generator frequency is controlled by a DC voltage connected to rear panel socket FREQUENCY CONTROL VOLTAGE "In" (see section 2.2). With no voltage connected, the Generator Output is off and the frequency display blacked out.

The right-hand switch determines sweep characteristics:

"Lin.": Gives a linear frequency sweep characteristic from 10 Hz to 20 kHz as indicated on the outer frequency scale.

"Log.": Gives a logarithmic sweep from 10 Hz to 20 kHz as indicated on the inner frequency scale.

FREQUENCY DIAL: Black knob with pointer for setting the generator frequency. May be moved manually or by an external drive. Note that 0 Hz on the linear scale (outer) corresponds to 20 Hz on the log. scale (inner).

FINE FREQUENCY CONTROL: Permits fine adjustment of frequency through a 50 : 1 gear reduction. Rotating the control down increases the frequency. This control cannot be used if the mechanical drive from a Level Recorder is connected unless the Level Recorder's gearbox is first clutched out (see section 3.3).

SCALE ALIGNMENT: For alignment of the logarithmic frequency scale at low frequencies (10 Hz or 20 Hz).

FREQUENCY DISPLAY: A 5 digit display indicating the generator frequency. The display blacks out when the FREQUENCY DIAL is set outside the Upper and Lower frequency limits which are set on the rear panel.

COUNTING TIME: A counting time of 0,1 s gives 10 frequency readings per second with a resolution of 1 Hz. A 1 s counting time gives one reading/s with a 0,1 Hz resolution to about 9500 Hz. Above 9500 Hz the counting time automatically switches to 0,1 s to prevent display overflow.

MODULATION FREQUENCY: Switch for selection of either internally or externally controlled frequency modulation of the generator. The internal frequencies of 1; 2,5; 6,3 and 16 Hz have a modulation swing of ± 10% of the center frequency up to 2500 Hz. Above 2500 Hz the frequency deviation is a constant ± 250 Hz. The influence of the modulation is seen in the changing of the FREQUENCY DISPLAY. External modulation or a fixed frequency offset is achieved by connection of an appropriate DC voltage to the FREQUENCY CONTROL VOLTAGE "In" socket on the rear panel (section 2.2).

2.2. REAR PANEL

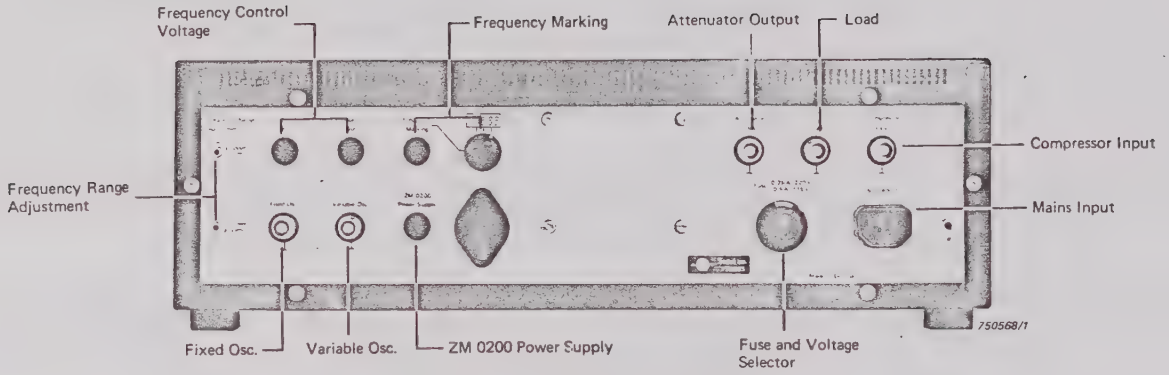


Fig.2.3. Rear panel of 1023

FREQUENCY RANGE ADJUSTMENT:

Multi-turn screwdriver-operated adjusters for setting the upper and lower frequencies of the 1023 to any desired values. The settings give a certain position of the FREQUENCY DIAL for cut-off, hence the actual frequency depends on whether a "Lin." or "Log." scale is selected. Turning the adjusters clockwise increases the frequency limit. The settings of the adjusters can be determined by observing the points at which the FREQUENCY DISPLAY blacks out and the Generator output voltage drops to 0.

FREQUENCY CONTROL VOLTAGE:

Both "In" and "Out" sockets are 8 pin DIN sockets accepting plug JF 0802 or cable AQ 0034. Pin designations are shown in Fig.2.4.

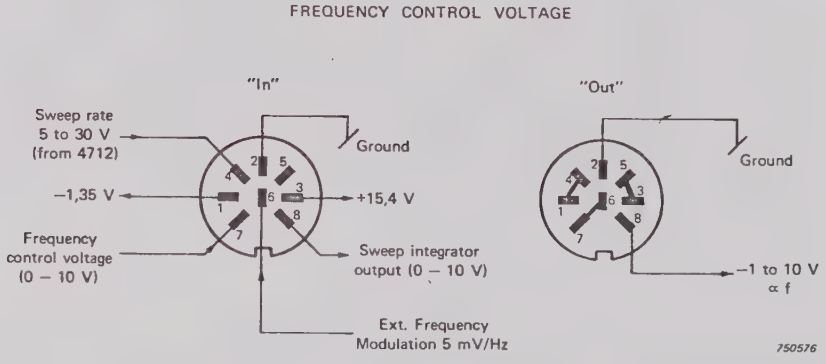


Fig.2.4. Connections to FREQUENCY CONTROL VOLTAGE sockets (external view)

"In": Provides the following functions:

1. Control of generator frequency by DC voltage ramp (pins 7 and 2). When the socket is connected to Level Recorder Type 2307 or 2309 by cable AQ 0034, the voltages of + 15,4 V and —1,35 V on pins 3 and 1 are applied across a potentiometer in the Level Recorder whose setting is controlled by the paper position. The pick-

off voltage from the potentiometer is fed back to pin 7 of the 1023 to control its frequency electrically. X-Y Recorder Type 2308 provides a voltage sweep which is used in a similar way (see section 3.3). Sensitivity is 0,5 mV/Hz (Lin.) or 1 V/octave (Log.).

2. Control of the sweep integrator of the 1023 when used with Frequency Response Tracer 4712 (see section 3.6.). The rate of change of voltage on pin 8 is —0,076 times the voltage applied to pin 4 within the operating range.

3. Frequency modulation or frequency off-set by a DC voltage to pin 6. Sensitivity is 5 mV/Hz. A function generator is well suited for modulating the 1023.

"Out": Pin 8 gives a voltage from 0 to 10 V proportional to frequencies of 10 Hz to 20 kHz (Lin.) or a voltage from —1 to 10 V for frequencies from 10 Hz to 20 kHz (Log.). May be connected directly to the X-INPUT socket of the Level Recorder Type 2307 using cable AQ 0034 or the Type 2308 (or any other) X-Y Recorder using a modified control cable.

FREQUENCY MARKING: 7 pin DIN socket giving frequency marking pulses on the change of the second, third, or fourth digits of the display as selected by the switch to the right of the socket. Uses cable AQ 0035 to connect to Level Recorder 2307. An interlock permits marking to ocur only when the Paper Drive is on. Connection diagram is given in Fig.2.5.

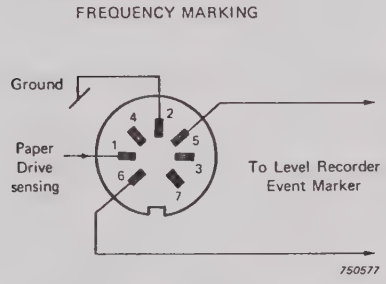


Fig.2.5. Connections to FREQUENCY MARKING socket (external view)

FIXED OSC.: BNC socket providing 120 kHz for connection to Heterodyne Slave Filter Type 2020 or Constant Output Level Adaptor ZM 0200.

VARIABLE OSC.: BNC socket providing a variable 240 to 200 kHz signal to tune Heterodyne Slave Filter Type 2020 in synchronization with the Sine Generator Type 1023, or for use with Constant Output Level Adaptor ZM 0200.

Both the FIXED OSC. and VARIABLE OSC. sockets may be connected to Constant Output Level Adaptor ZM 0200 which is powered from the ZM 0200 POWER SUPPLY socket, Fig.2.6. The ZM 0200 mixes and low pass filters the two high frequency signals giving a low frequency output whose amplitude is approximately 1 V RMS and independent of any front panel amplitude controls.

ZM 0200 POWER SUPPLY: Provides for Constant Output Level Adaptor ZM 0200. Remote cont of the GENERATOR on-off function is also provided. Shorting pins and 3 gives GENERATOR "off". See Fig.2.6.

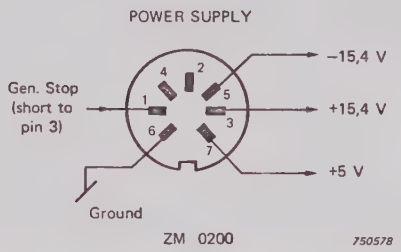


Fig.2.6. Connections to ZM 0200 POWER SUPPLY socket (external view)

FUSE AND VOLTAGE SELECTOR: Six-position switch locked by the engagement of an integral fus holder. Permits the selection of 50 to 400 Hz AC mains at 100, 11 127, 150, 220 or 240 V. Do not attempt to connect mains to the i strument without first following the instructions on mains voltage a fuse selection in section 3.1.2.

MAINS INPUT: Three-pin IEC fixed plug to CEE 22 for connection of a mains supp Accepts power cable AN 0010 (provided). Do not attempt to conne mains to the instrument without first following the instructions mains voltage selection and fuse checking in section 3.1.2.

The following three BNC sockets parallel the corresponding front panel sockets:

ATTENUATOR OUTPUT

LOAD

COMPRESSOR INPUT

2.3. SIDE PANELS

A mechanical drive shaft socket is located on each side of the 1023. The socket on t left side (as viewed from the front) connects to Flexible Drive Shaft UB 0041 whi transmits the drive from Level Recorder Type 2307. This will give a sweep with incre sing frequency. If a backwards frequency sweep is desired, the drive shaft from the L vel Recorder should be connected to the right side socket. The drive socket on the rig side may also be used to connect to another B & K instrument.

3. OPERATION

3.1. PRELIMINARY

3.1.1. Mounting

The 1023 can be used free-standing (Cabinet Type A), in a mahogany case KA 0059 (Cabinet Type B), or rack-mounted (Cabinet Type C for 19-inch International Standard racks). The two forward plastic feet incorporate legs which may be hinged down to tilt the 1023 for easier operation. The kit for rack-mounting is B & K UA 0480, which includes chain sprocket UT 0024 to enable the 1023 to be swept in frequency in synchronization with the paper throw of a Type 2307 Level Recorder (or the earlier Type 2305) when both are mounted in the same rack.

3.1.2. Connection of Mains Supply

Before connecting a mains supply, carry out the following checks and adjustments to ensure safe operation of the apparatus.

Voltage and fuse selection

The 1023 may be powered from 100, 115, 127, 220 or 240 V ± 10%, 50 to 400 Hz single-phase AC mains lines. To select the correct mains voltage setting, unscrew and remove the FUSE using a wide-bladed screwdriver. Pull the black plastic outer disc (containing a voltage indicating window) right out and replace it so that the correct mains voltage is displayed in the window.

Check the rating of the FUSE. For 100, 115 or 127 V it should be a 500 mA slow-blow fuse (B & K VF 0023). For 220 or 240 V it should be a 250 mA slow-blow fuse (B & K VF 0031). Replace the FUSE.

Note: Make sure that only fuses with the required rated current an of the specified type are used for replacement. The use of mended fuses and of short-circuiting of fuse-holders is prohibited.

Supply connections

Once mains voltage setting and fuses have been checked, the mains supply may be connected to the MAINS INPUT socket using the Power Cable AN 0010 provided. To fit a suitable mains connector to the cable, refer to Fig.3.1.

For maximum operating safety it is recommended that the protective (green/yellow) conductor of the cable be connected to suitable earth, such as the protective earth contact of a mains outlet socket. The use of an extension cable without protective conductor should be avoided.

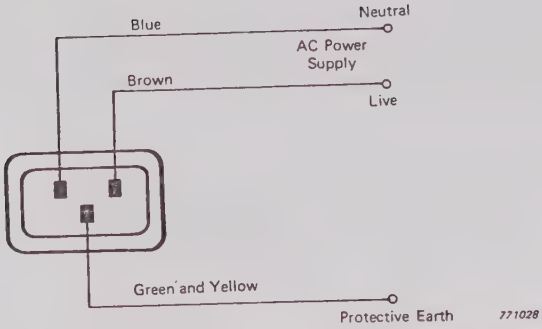


Fig.3.1. Connections to the MAINS INPUT of the 1023 (external view)

3.1.3. Earthing Considerations.

When the 1023 is used together with a number of other instruments, care should be taken to avoid the introduction of earth loops in the interconnection arrangements. An earth loop (sometimes described as a ground loop) arises when two or more separate points which are at earth, ground or 0 V potential are connected together by two physically separated low-resistance paths. Such loops are very prone to the induction of circulating currents which can result in significant interfering voltages — most often at mains frequency — in circuits carrying small signals. This interference can in turn lead to measurement errors.

An earth loop is eliminated by breaking the ground connection at one point. A common source of earth loops is the protective earths of the power cables of two instruments connected together by screened cable. The loop may be broken by disconnecting the cable screen at one end, or by disconnecting the protective earth of one of the instruments. If the cable screen is disconnected, a voltage induced from the mains leads in the two protective earths will appear across the signal circuit and possibly cause as big a measurement error as the original earth loop. If a protective earth is disconnected, the risk of measurement error from this cause is removed, but a potentially hazardous situation is created since one of the power cables now no longer has a continuous protective earth, and this fact may be forgotten when the measuring installation is dismantled. Although all B & K mains powered instruments have a high standard of reinforced insulation, maximum safety cannot be assured unless all accessible metalwork is protectively earthed. The indiscriminate disconnection of cable protective earths is therefore to be strongly discouraged **unless** the mains supply used for the entire installation incorporates personnel protection by means of an earth-leakage circuit-breaker (ELCB).

For the systematic elimination of earth loops, the following procedure is recommended.

1. Connect the Signal Ground lines of all instruments together. Where instruments are connected by screened cables, this connection is made automatically through the screen.

2. If one or more of the instruments in the installation is designed to be earthed through its power cable, connect Signal Ground on one instrument of this class and one only to its chassis, and ensure that its chassis is protectively earthed through the power cable.

3. On each of the other instruments, either (a) disconnect Signal Ground from Chassis (where a removable link is provided for this purpose) and ensure that the instrument is protectively earthed through its power cable, or (b) disconnect the protective earth (where Signal Ground and Chassis cannot be separated, as on the 1023), mark

power cable clearly, as a warning to other users, and complete this procedure before applying power to this power cable (to eliminate the possibility of energising the instrument before it becomes earthed through a signal cable).

4. If instruments designed for use without a protective earth or instruments operating from low voltage supplies are included in the installation and are used without their Chasses touching or interconnected, check that on each of these instruments the Chassis is connected to the Signal Ground.

5. If some or all the instruments are mounted in a rack so that their Chasses might be interconnected;

   (a) check that there is in fact good electrical continuity between each metal-cased instrument and the rack;

   (b) check that the rack is protectively earthed through one power cable and only one;

   (c) break the connection between Signal Ground and Chassis on all but one of the instruments, if possible, or disconnect Signal Ground connections between instrument pairs where both instruments have permanent Signal Ground/Chassis connections.

6. Check for earth loops completed by the metal housings of measurement transducers, and eliminate them by isolating the transducers electrically from the specimen. Avoid earthing the specimen through the transducer screen.

The 1023 does not include facilities for disconnecting Signal Ground from Chassis.

If it proves unpractical to implement the above procedure, an earth loop can be broken by inserting a Balancing Transformer TI 0001 or TU 0005 into a signal path carrying audio frequencies. These two isolating transformers have wide audio frequency bandwidths and low distortion. For further details, consult your B & K representative.

3.2. BASIC OPERATION

Before using the 1023 it is recommended to initialise it by setting the following controls as indicated:

POWER:	"On"
GENERATOR:	"On"
REF. SIGNAL:	"Off"
SWEEP CONTROL:	"Manual/Ext. Mech." and "Log"
COMPRESSOR SPEED:	"Off"
MODULATION FREQUENCY:	"Mod.Off"
COUNTING TIME:	"0,1 s"

The amplitude and frequency controls can now be set as required.

3.3. USE WITH GRAPHIC RECORDERS

A valuable feature of the 1023 is the ease with which it may be accurately synchronized with other instruments for swept-frequency measurements as, for example, in Fig.3.2. For synchronization with B & K level and X-Y recorders, details are given in the following sections. It may also be synchronized with most other manufacturers' X-Y recorders, but

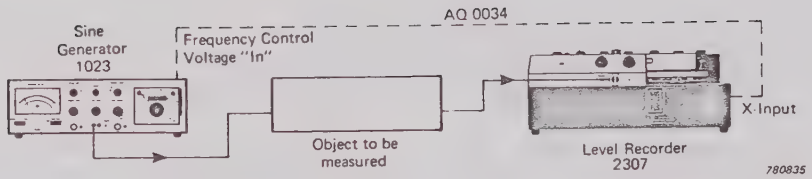


Fig.3.2. Typical arrangement of equipment for making automatic frequency response recordings

the details of control cables and procedures are left to the user to work out, using the in formation given in Chapter 2.

It is very often convenient when recording frequency sweeps covering a smaller fre quency range than 10 Hz to 20 kHz to limit the 1023 frequency sweep to the recorde range. The 1023 includes two FREQUENCY RANGE ADJUSTMENT controls situated or the left hand side of the rear panel, which enable the upper and lower limits to be se anywhere within the frequency range of the 1023. These limits relate to positions or the FREQUENCY DIAL (although they operate at the corresponding frequencies whe SWEEP CONTROL is set to "Ext. Electr.") — they therefore occur at different frequencie according to whether "Log." or "Lin." is selected. When the synchronized recorde moves outside the frequency range limits set up with these controls, the output of th 1023 is disabled and the FREQUENCY DISPLAY becomes blank.

3.3.1. Level Recorder 2307

There are three methods of synchronizing the frequency of the 1023 with the pape throw of the Type 2307 Level Recorder — mechanical drive from the 2307, electrica drive from the 2307, and electrical drive from the 1023. The procedures for synchroniza tion by each method in turn are described below. Several different types of recordin paper are available with logarithmic frequency graduations printed on them for us when logarithmic frequency sweeping is required. However, for linear frequency sweep ing the normal recording paper used has no frequency graduations, and the 2307 incor porates a separate Event Marker which may be actuated by the FREQUENCY DISPLAY c the 1023 so as to record frequency marks in the margin of the recording paper automat cally during the sweep. To use this facility connect a Control Cable AQ 0035 (Fig.3.

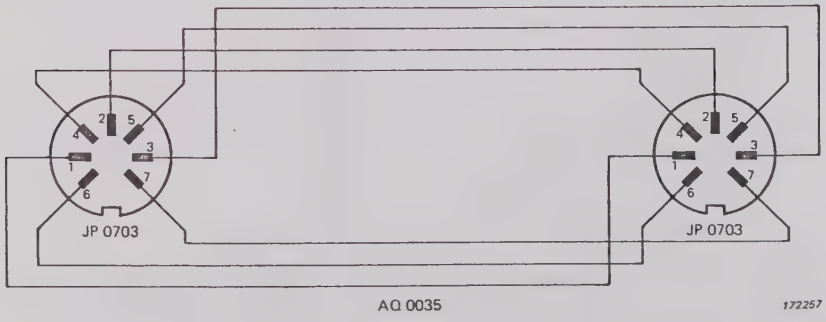


Fig.3.3. Control cable AQ 0035

between the REMOTE CONTROL socket on the 2307 and the FREQUENCY MARKIN socket on the 1023, and load a pen into the Event Marker Pen Holder on the 2307. Th Event Marker will write a narrow mark every time the digit selected on the FREQUENC

MARKING switch (adjacent to the FREQUENCY MARKING socket on the 1023) changes. It will also write a broad mark every ten narrow marks, simultaneously with the change of the next digit up.

Mechanical drive from the 2307

A Flexible Shaft UB 0041 is supplied with the 1023 to drive its tuning control mechanically from the paper drive of the 2307. The Flexible Shaft is connected between the socket on the left side of the 1023, and either the DRIVE SHAFT I or DRIVE SHAFT II sockets on the Level Recorder. DRIVE SHAFT I is used for logarithmic frequency sweeping using frequency-graduated recording-paper, and for linear frequency sweeping with a paper throw of 150 mm corresponding to the full linear range of the FREQUENCY DIAL on the 1023. DRIVE SHAFT II is for obtaining a frequency scan over a compressed or expanded frequency scale on level graduated paper without frequency graduations. The rotation of DRIVE SHAFT I is determined by the setting of the PAPER SPEED knob of the Recorder, whilst that of DRIVE SHAFT II is determined by the setting of the DRIVE SHAFT II SPEED knob and is independent of paper speed.

To synchronize the 1023 and the 2307 mechanically, proceed as follows, disregarding steps 6 to 11 for linear frequency sweeping.

1. On the 1023 set controls:

POWER ON	Up position
SWEEP CONTROL	"Manual Ext. Mech."
	"Lin." or "Log." as required

2. On the Level Recorder set controls:

POWER	"On"
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	"10 mm/s"
DRIVE SHAFT II SPEED	"12 rpm"

3. Press the PAPER DRIVE "Start" button on the Level Recorder and screw one end of the flexible Drive Shaft into DRIVE SHAFT I or II socket. When correctly coupled the inner part of the shaft should begin to rotate.

4. Screw the other end of the Flexible Drive Shaft into the DRIVE SHAFT socket on the left side panel of the 1023. When the Shaft is correctly coupled the frequency scale pointer of the instrument should start to move.

5. Press the PAPER DRIVE "Stop" button on the Level Recorder and load a roll of suitable recording paper.

6. Turn the PAPER ADJUSTMENT and AUTOMATIC STOP wheels so that the white spots marked on the wheels coincide and that these appear in the centre of the opening on the front of the Recorder.

7. With the PAPER DRIVE FUNCTION switch set to "Automatic Stop F", press the PAPER DRIVE "Start" button and wait until the paper drive stops automatically.

8. Lift up the guide clip above the paper drive sprocket wheel and move the recording paper so that the required starting frequency on the chart is directly (or as near as possible) under the pen.

9. If the required starting frequency on the chart falls just before (or just after) the pen, turn the AUTOMATIC STOP wheel so that its white spot is a corresponding distance above (or below) the white spot on the PAPER ADJUSTMENT wheel. The range of adjustment is ± 12,5 mm.

10. Turn the PAPER ADJUSTMENT wheel so that the paper moves forward by about 5 mm. This will remove any backlash in the paper movement.

11. Press the PAPER DRIVE "Start" button so that the paper is moved forward to the next chart where it should stop automatically at the required starting frequency for recording. If not repeat items 9 to 11.

12. Turn the FREQUENCY DIAL on the 1023 so that the frequency scale pointer is set to the required starting frequency.

The Level Recorder and the 1023 are now synchronized. When DRIVE SHAFT I is used for logarithmic frequency scanning any PAPER SPEED knob setting may be selected without losing synchronization. To retain synchronization when DRIVE SHAFT II is used the DRIVE SHAFT II SPEED and PAPER SPEED knobs must be set to the same angular settings.

Electrical drive from the 2307

To synchronize the 1023 with the 2307 so that the frequency of the 1023 is determined by the paper throw of the 2307 via an electrical link (as in Fig.3.2), proceed as follows:

1. Set SWEEP CONTROL on the 1023 to "Ext. Electr." and "Lin." or "Log." as required.

2. Load the 2307 with suitable recording paper, and select a convient paper speed.

3. Connect Control Cable AQ 0034 (Fig.3.4) between FREQUENCY CONTROL VOLTAGE "In" on the 1023 and "X-INPUT" on the 2307.

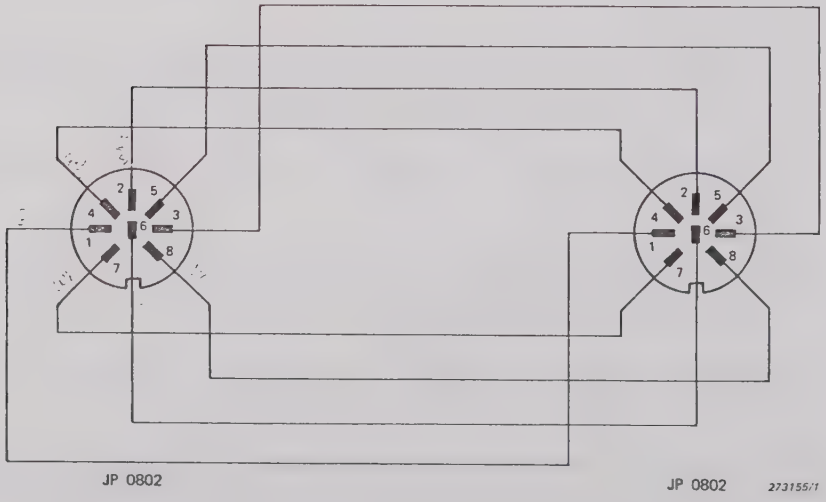


Fig.3.4. Control cable AQ 0034

4. Set PAPER DRIVE FUNCTION on the 2307 to "Automatic Stop — F" and momentarily depress the PAPER DRIVE "Start" button.

5. Wait until the paper drive stops automatically.

6. If linear frequency sweeping is required, move the AUTOMATIC STOP wheel if necessary so that the white spots line up.

7. If logarithmic frequency sweeping in required, determine whether the white spot on the PAPER ADJUSTMENT WHEEL is higher or lower than that on the AUTOMATIC STOP wheel.

8. If lower, switch PAPER DRIVE FUNCTION to "Automatic Stop — R".

9. Line the two spots up.

10. Depress the PAPER DRIVE "Start" button momentarily.

11. Wait till the paper drive stops.

12. Lift up the guide clip above the paper drive sprocket wheel of the Recorder and feed the recording paper to re-engage it in the sprocket wheel with the 20 Hz frequency graduation as close to the pen or stylus point as possible.

13. Adjust SCALE ALIGMENT on the 1023 to bring the displayed frequency into correspondence with the actual position of the pen relative to the frequency scale on the recording paper.

14. Switch PAPER DRIVE FUNCTION back to "Automatic Stop — F".

15. Advance the paper manually or by using the paper drive to line the pen up with the 10000 Hz graduation.

16. Check that the FREQUENCY DISPLAY on the 1023 agrees with the paper position to an acceptable standard of accuracy (the pointer of the FREQUENCY DIAL should lie within scale limits).

17. If it does not, adjust it by means of the Control Voltage Adjustment potentiometer shown in Fig.3.5. Access to this is gained by removing the bottom panel of the 2307, which is held in place by three screws. WARNING: Before removing this panel, disconnect the power cable to the 2307 (the adjustment requires power only on the 1023). Internal adjustments with mains power connected should be carried out only by skilled persons who are aware of the hazards of dealing with live circuitry.

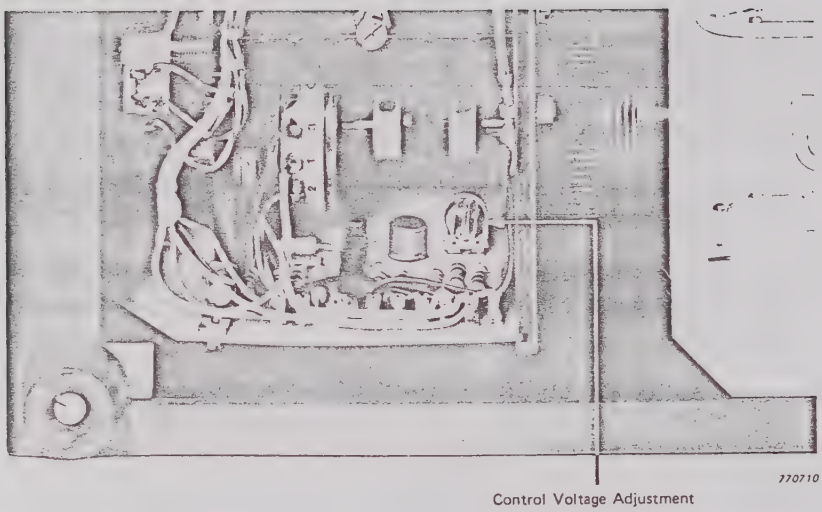


Fig.3.5. View of part of the interior of the 2307 Level Recorder with the bottom panel removed, showing the position of the Control Voltage Adjustment (circuit ref. P 10)

Electrical drive from the 1023

The 2307 paper throw may be controlled by a voltage ramp in the "X-Rec." setting of the PAPER DRIVE FUNCTION switch. This facility enables paper movement to be slaved to changes in the frequency of the 1023. Normally this facility will be useful only for non-uniform or irregular frequency sweeping, by manipulation of the FREQUENCY DIAL on the 1023. It may also be used when the frequency of the 1023 is itself frequency controlled from a third instrument via the FREQUENCY CONTROL VOLTAGE "In" socket. The procedure for synchronizing the 1023 and the 2307 using the X-Recording facility is as follows (for linear sweeping disregard steps 10 to 18; for logarithmic sweeping disregard steps 19 to 25):

1. Set the controls on the 1023 as required.

2. Load the 2307 with suitable recording paper.

3. Connect Cable AQ 0034 (Fig.3.4) between FREQUENCY CONTROL VOLTAGE "Out" on the 1023 and X-INPUT on the 2307.

4. Set the frequency indicated by the FREQUENCY DISPLAY of the 1023 to 20 Hz.

5. Using the Polar Chart Pin or any convenient small screwdriver, turn the X-RECORDING "Zero" ADJUSTMENT (located on the 2307 Side Panel) up to 25 times anticlockwise until a distinct click is heard (or felt); then turn it back clockwise, counting 10 turns (not critical). The object of this is ensure that the initial synchronization position of the paper lies within the range of the paper drive servo.

6. Switch PAPER SPEED on the 2307 to "3 cm/sec."

7. Switch PAPER DRIVE FUNCTION on the 2307 to "Automatic Stop — F".

8. Depress PAPER DRIVE "Start" on the 2307 momentarily.

9. If the paper stops with less than 250 mm of paper clear of the Recorder, press the button a second time.

10. For logarithmic frequency sweeping on frequency graduated recording paper lift up the guide clip above the paper drive sprocket wheel of the Recorder and feed the recording paper to re-engage it in the sprocket wheel so that the pen lies approximately midway between two charts (e.g., about level with the 2 Hz graduation on QP 1143 recording paper).

11. Switch PAPER DRIVE FUNCTION to "X-Rec."

12. Depress the PAPER DRIVE "Start" button momentarily.

13. When the paper comes to rest, adjust X-RECORDING "Zero" again to bring the paper to rest with the 20 Hz graduation lying beneath the pen.

14. Advance the frequency of the 1023 to 200 Hz.

15. Adjust X-RECORDING "Sensitivity" to bring the paper to rest with the 200 Hz graduation lying beneath the pen.

16. Advance the frequency of the 1023 to 10000 Hz.

17. Adjust X-RECORDING "Sensitivity" to bring the paper to rest with the 10000 Hz graduation lying beneath the pen.

18. Return the frequency of the 1023 to 20 Hz and check that synchronism is retained. If it has been disturbed, repeat steps 13, 16, 17 and 18 until synchronization is correct at both 20 Hz and 10000 Hz.

19. For linear frequency sweeping on recording paper without frequency graduations, switch PAPER DRIVE FUNCTION to "X-Rec."

20. Depress the PAPER DRIVE "Start" button momentarily.

21. Turn the X-RECORDING "Zero" adjustment clockwise, slowly enough to enable the paper drive to keep up, until the white spot on the PAPER ADJUSTMENT sprocket is centred in the window in the Front Panel of the 2307.

22. Turn the X-RECORDING "Sensitivity" adjustment clockwise up to 25 turns until a distinct click is heard (or felt).

23. Advance the frequency of the 1023 to 20000 Hz.

24. When the paper stops, turn the X-RECORDING "Sensitivity" adjustment slowly anticlockwise, allowing the paper drive to keep up, until the point is reached where the movement of the paper no longer corresponds to the rotation of the screwdriver (because the paper simply drives continuously, or stops).

25. Turn the X-RECORDING "Sensitivity" clockwise one turn.

The paper will now be synchronized. However, if the frequency of the 1023 goes outside scale limits, the paper may feed backwards or forwards to the next chart length, and may stop 250 mm from the required position. In this event use the PAPER DRIVE and PAPER DRIVE FUNCTION controls to re-establish synchronization without altering the adjustments.

The procedure of steps 19 to 25 above provides for frequency coverage of 20000 Hz on a chart length of nearly 250 mm. By means of the X-RECORDING adjustments it is possi-

ble to synchronize a reduced portion of the 1023 frequency range on the same length chart, and this is equivalent to expanding the recording for many applications. Howeve some care is needed in using the adjustments to avoid requiring the paper to feed to th point where the white spot on the sprocket wheel lies at the top end of the window the Front Panel of the 2307, since this point marks the limits (in both directions) for ele trical synchronization of any given chart, and beyond that point the paper will start feed continuously.

3.3.2. X-Y Recorder 2308

There are two methods of synchronizing the frequency of the 1023 with the 2308 electrical drive from the 2308, and electrical drive from the 1023. The former is wider application since the 2308 incorporates a versatile sweep generator.

It is usual to sweep the frequency along the X-axis when making graphic recording and the frequency-graduated recording paper available for the 2308 is designed for th style of graph. However, either synchronization method may be adapted if required for axis frequency sweeping. The Y-axis is parallel to the shorter sides of the recordi area.

Electrical Drive from 2308

The procedure for synchronizing the 1023 for frequency sweeping under the control the 2308 is as follows.

1. Connect a control cable made up as in Fig.3.6 between FREQUENCY CONTROL VO TAGE "In" on the 1023 and REMOTE 2 on the 2308. Take care to connect it th right way round — the wrong connection will not cause damage to the instrument but the arrangement will not operate.

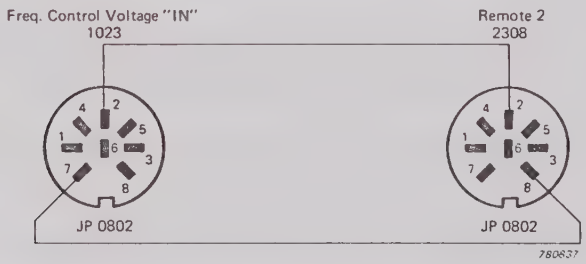


Fig.3.6. Control cable for connection between FREQUENCY CONTROL VOLTAGE "In" on the 1023 and REMOTE 2 on the 2308

2. Set SWEEP CONTROL on the 1023 to "Ext. Electr." and the other controls as r quired (ensure that the pointer of the FREQUENCY DIAL lies within scale limits).

3. Load the 2308 with suitable frequency-graduated recording paper.

4. Set the X channel controls on the 2308 as follows:

SWEEP:	"Int."
POLARITY:	"Norm."
GAIN:	"Cal." click-stop position
RANGE:	"41,7 — Cal."

5. On the 2308, set SWEEP to "Hold" and depress the "Reset" button momentarily.

6. Adjust X ZERO SET on the 2308 to line the pen up with the left-hand extremity of the frequency scale on the recording paper (0 for linear sweeping, 20 for logarithmic sweeping). it is easiest to do this with the pen lowered, i.e., press gently on the top of the pen.

7. For logarithmic sweeping, adjust SCALE ALIGNMENT on the 1023 to obtain a reading of 20 Hz on the FREQUENCY DISPLAY.

The combined sweep accuracy of the 1023 and the 2308 is very high. However, any residual frequency error may be eliminated if required by switching X RANGE to "20" and adjusting X GAIN to line the pen up against the graduation corresponding to the displayed frequency. The latter may be ramped up or down to convenient round value by setting SWEEP RATE to a low number and SWEEP to "Normal" or "Reverse" for long enough to bring the indicated frequency on the 1023 to the required value. It is permissible to change SWEEP RATE during the sweep for this purpose.

The above procedure, although the simplest to execute, does not allow the 10—20 Hz part of the 1023's logarithmic frequency range to be used. It also results in the "Reset" state of the sweep generator corresponding to 20 Hz. It is possible to sweep from 10 Hz to 10 kHz logarithmically, for example, if the control cable used in Step 1 is replaced by a control cable similar to AQ 0034 (Fig.3.4) but with pin 8 disconnected at one end. In this arrangement the 10-turn RAMP SET control on the 2308 should be adjusted to align the required frequency range with the sweep generator. One turn shifts the logarithmic frequency scale about two-thirds of a decade. The graduations on the recording paper should be altered or modified.

To record only a part of the available frequency range on an expanded frequency scale, first graduate suitable recording paper, and then adjust the X controls as necessary to line up the end frequencies on the paper with those indicated on the FREQUENCY DISPLAY of the 1023.

Electrical Drive from 1023

The X sweep of the 2308 may very easily be slaved to the frequency of the 1023 using the standard Control Cable AQ 0034 (Fig.3.4) for applications involving a number of instruments and requiring a minimum of specially made up cables. To synchronize the 2308 with the 1023 for sweeping in frequency while recording on frequency-graduated paper, proceed as follows.

1. Connect Control Cable AQ 0034 (Fig.3.4) between FREQUENCY CONTROL VOLTAGE "Out" on the 1023 and REMOTE 1 on the 2308.

2. If the frequency range of the recording is 10 Hz to 20 kHz set the X controls on the 2308 as follows:

SWEEP:	"Ext."
POLARITY:	"Norm."
GAIN:	"Cal." click-stop position
RANGE:	"41,7 — Cal."

3. Depress X ZERO CHECK and keep it pressed while adjusting X ZERO SET to line the pen up with the 20 Hz graduation on the recording paper.

4. If the frequency range of the recording is to be significantly less than the full range of the 1023, then the X sensitivity of the 2308 should be increased by altering the settings of X RANGE and X GAIN. If the range does not encompass 20 Hz it will be necessary to adjust X GAIN and X ZERO "Set" iteratively at the higher and lower limits of the chosen range to obtain correspondence of the pen position in relation to the frequency graduations on the paper with the indication on the FREQUENCY DISPLAY of the 1023 at both frequencies.

3.3.3. Two-Channel Level Recorder Type 2309

The method of synchronizing the 1023 with the Type 2309 Two-Channel Level Recorder uses a paper-position potentiometer in the Recorder which is connected across the reference voltage available on the FREQUENCY CONTROL VOLTAGE "In" socket of the 1023. Synchronization for either linear or logarithmic frequency sweeping under the control of the 2309 is very easy. The procedure for synchronization is as follows.

1. Connect Control Cable AQ 0034 (Fig.3.4) between FREQUENCY CONTROL VOLTAGE "In" on the 1023 and REMOTE 2 on the 2309.

2. Set SWEEP CONTROL on the 1023 to "Ext. Electr." and "Log." or "Lin." as required and the other 1023 controls as required. The pointer of the FREQUENCY DIAL should lie within scale limits.

3. Load the 2309 with suitable recording paper.

4. For linear frequency sweeping, the instruments are now synchronized. If the 1023 FREQUENCY DISPLAY should be blank, use the RAMP ADJ. control of the 2309 to bring the control voltage within the working range of the 1023.

5. For logarithmic frequency sweeping, advance the recording paper to bring the pen adjacent to the 10000 Hz graduation using the PAPER ADJUSTMENT wheel.

6. Use RAMP ADJ. on the 2309 to set the frequency of the 1023 to 10000 Hz.

7. Return the recording paper to bring the pen adjacent to the 20 Hz graduation using the PAPER ADJUSTMENT wheel.

8. Adjust SCALE ALIGNMENT on the 1023 to obtain a reading of 20 Hz on the FREQUENCY DISPLAY.

Note that since the potentiometer in the 2309 is a passive component, the synchronization procedure may be carried out with power off the Recorder (but not off the 1023). If the Recorder is switched on, note also that the paper may not be fed manually when PAPER SPEED is set to "Ext." unless PAPER DRIVE is set to "Stop".

3.4. USE OF COMPRESSOR

The built in compressor of the 1023 provides for automatic regulation of level over a 60 dB dynamic range. The compressor is of such a design that under static conditions the level regulation will be error-free regardless of the degree of compression. In practice, sweep speeds, compressor speeds, and distortion must be taken into account to obtain the desired regulation.

Fig.3.7 shows a typical equipment arrangement which includes a compressor loop to keep constant the level at the Regulation transducer position as the frequency is swept. When an arrangement such as this is used, the following points should be noted:

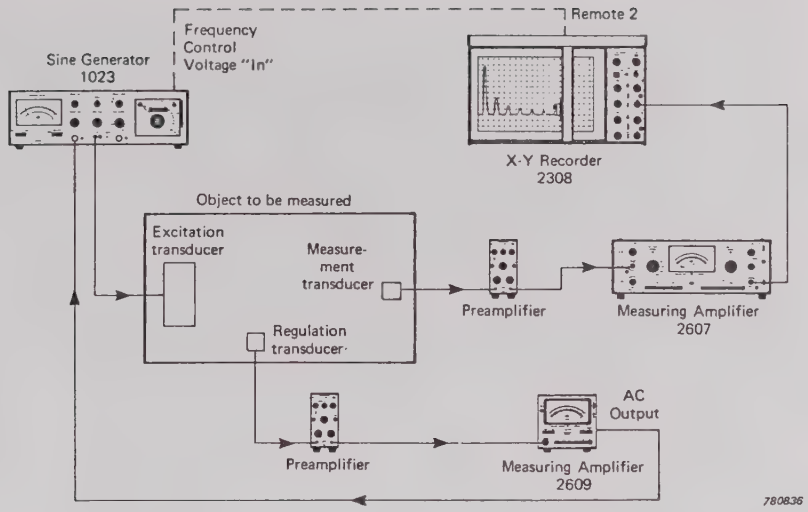


Fig.3.7. Typical arrangement of equipment using a compressor loop

1. The OUTPUT VOLTAGE and OUTPUT ATTENUATOR controls of the 1023 determine the maximum voltage available and the degree of compression. Increasing the OUTPUT VOLTAGE increases the amount of compression, but does not increase the output level.

2. The output level is controlled by the COMPRESSOR VOLTAGE. Turning the control clockwise increases the degree of compression and decreases the output level.

3. Often an external amplifier is used to drive the COMPRESSOR INPUT socket. This amplifier must deliver at least 0,5 V RMS in order to activate the compressor. Increasing the gain of this compressor amplifier will decrease the output level of the 1023 proportionately.

4. In general, the lowest degree of compression possible should be used to limit the amount of drive available should the compressor loop accidentally be opened. Minimum compression also optimizes the signal to noise ratio of the generator.

5. If filtering is used in the compressor feedback loop, a combination of too high a COMPRESSOR SPEED and too narrow a filter bandwidth may result in instability and potentially destructive oscillations.

6. The distortion of the generator output is related to both the COMPRESSOR SPEED and the frequency as indicated in Fig.3.8.

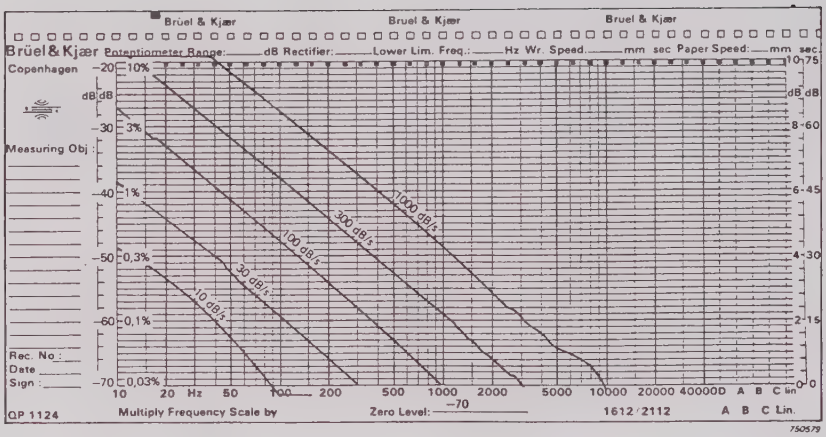


Fig.3.8. Typical third harmonic distortion as a function of COMPRESSOR SPEED and frequency. The second harmonic is approximately 10 dB lower

3.5. USE WITH BAND PASS FILTERS

The Type 2020 Heterodyne Slave Filter (for constant bandwidth) and the Type 16 Tracking Filter (for constant-percentage bandwidth) may be frequency-synchronized w the 1023. For measurement of harmonics the Type 2020 may be tuned to a constant tegral multiple of the 1023 by the use of the Tracking Frequency Multiplier Type 19 If a compressor loop is used and the amount of compression needed is substantial Constant Output Level Adaptor ZM 0200 may be needed to provide a signal to wh the 1623 or 1901 may lock.

3.5.1. Heterodyne Slave Filter 2020

To synchronize the centre frequency of the 2020, first calibrate the Filter as described its Instruction Manual, then connect FIXED OSC. on the 1023 to 120 kHz on the 202 and VARIABLE OSC. on the 1023 to 100 kHz — 120 kHz on the 2020 (see Fig.3.9). the 2020, set BFO MODE to "Sine" and proceed as described in the Instruction Man for the 2020.

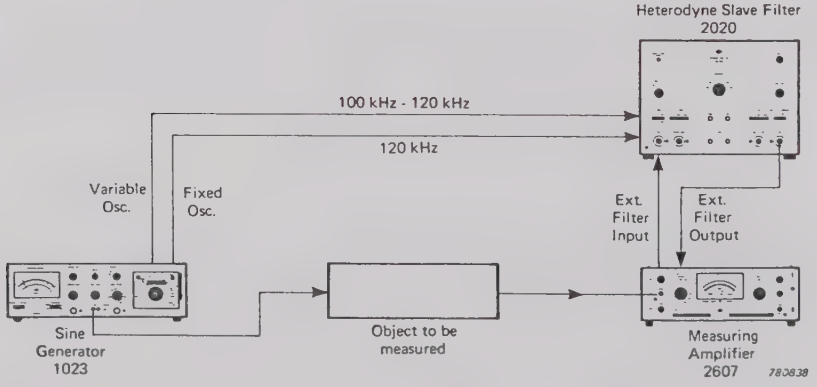


Fig.3.9. Typical arrangement of equipment using a Type 2020 Heterodyne Slave Filter

3.5.2. Tracking Filter 1623

To synchronize the Tracking Filter Type 1623 with the frequency of the 1023 or integral multiples or submultiples of this frequency, connect the LOAD output on the 1023 to TACHOMETER INPUT on the 1623 (see Fig.3.10). Set TRACKING MODE on the 1623 to "Tachm. Input" and TRIGGER LEVEL to its central position. Set the other controls as required, referring to the 1623 Instruction Manual for full details of the procedure.

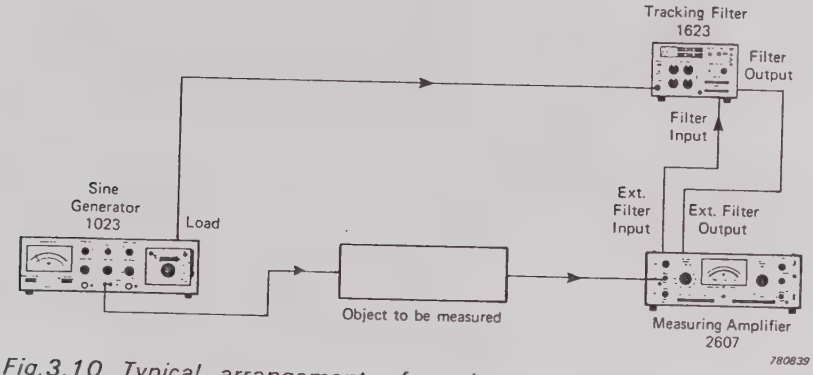


Fig.3.10. Typical arrangement of equipment using a Type 1623 Tracking Filter

3.5.3. Tracking Frequency Multiplier 1901

The Tracking Frequency Multiplier Type 1901 may be used to synchronize the Heterodyne Slave Filter Type 2020 to integral multiples of the frequency of the 1023. To set up the instruments, make the following interconnections (see Fig.3.11):

LOAD (1023)	to	INPUT f1 (1901)
VARIABLE OSC. (1901)	to	100 kHz — 120 kHz (2020)
FIXED OSC. (1901)	to	120 kHz (2020)

Set TRIGGER LEVEL on the 1901 to its central position. For details of how to operate the 1901 and 2020, refer to their Instruction Manuals.

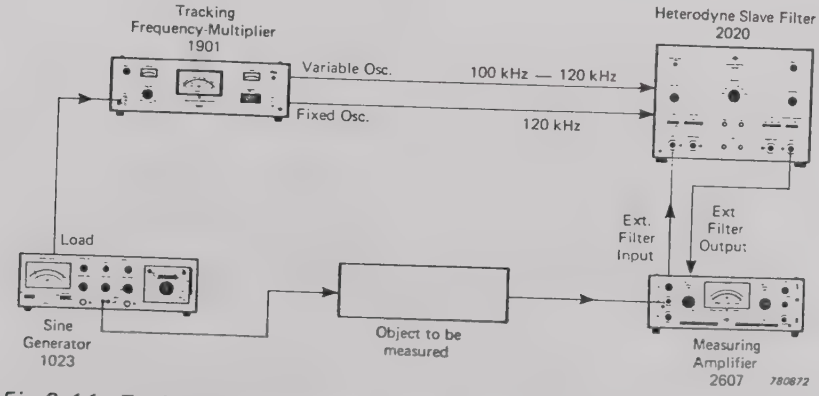


Fig.3.11. Typical arrangement of equipment using a Type 1901 Tracking Frequency Multiplier

3.5.4. Constant Output Level Adaptor ZM 0200

The compressor in the 1023 has a 60 dB range, and under extreme compression the output voltage may become less than the minimum needed to trigger the 1623, the 1901, the 4911 Motion Analyzer, the 4712 Frequency Response Tracer, or other equipment. To provide a trigger signal independent of the operation of the compressor and level-setting controls, a Constant Ouput Level Adaptor ZM 0200 (Fig.3.12) should be attached to the FIXED OSC. and VARIABLE OSC. BNC sockets on the rear of the 1023 by means of its two BNC fixed plugs (which are provided with locking rings just like BNC free plugs). These fixed plugs are labelled with the title of the corresponding socket on the 1023. The seven-pin DIN plug should be plugged into the ZM 0200 POWER SUPPLY socket in the 1023. The constant output, which has a level of 1,0 V RMS and is sinusoidal, is available at the single BNC socket in the top of the Adaptor, and the FIXED OSC. and VARIABLE OSC. signals are available on labelled BNC sockets on the rear of the Adaptor for synchronizing a 2020 Heterodyne Slave Filter not controlled by a 1901. Note that the constant output is not extinguished outside the chosen limits of the 1023 frequency range.

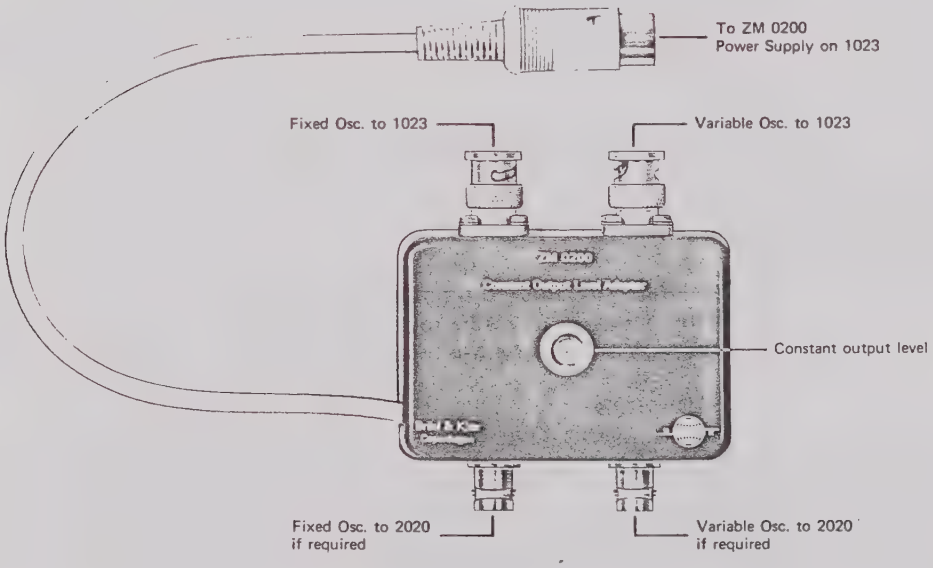


Fig.3.12. ZM 0200 Constant Output Level Adaptor

3.6. USE WITH FREQUENCY RESPONSE TRACER 4712

A built in sweep ramp generator in the 1023 provides for automatic generation of frequency sweeps when used with Frequency Response Tracer Type 4712.

1. Make the connections indicated in Fig.3.13. between the FREQUENCY CONTROL VOLTAGE "In" socket of the 1023 and the MOTOR DRIVE socket of the 4712.

2. Connect the output from the object under test to the SIGNAL INPUT of the 4712 and set the INPUT ATTENUATOR and POTENTIOMETER to get an on-screen deflection.

   It is recommended to trigger the 4712 via its EXT. FREQUENCY INPUT using the Constant Output Level Adaptor ZM 0200 (Fig.3.12) which attaches to rear of the 1023. The ZM 0200 is provided with the Frequency Response Tracer Type 4712. For details of how to connect the ZM 0200 see section 3.5.4.

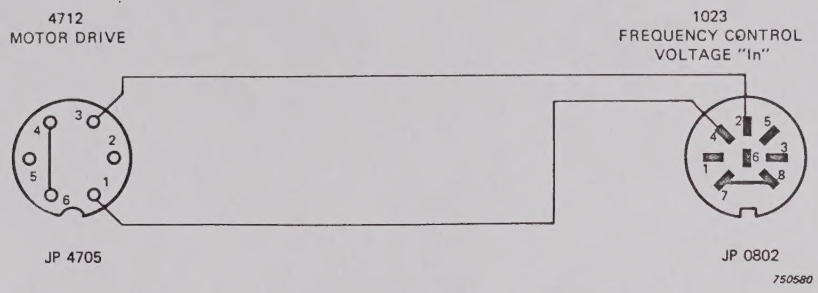


Fig.3.13. Connections between the 4712 MOTOR DRIVE and 1023 FREQUENCY CONTROL VOLTAGE "In" sockets (external view)

3. Set RETURN MODE on the 4712 in the anticlockwise position. Then set the FREQUENCY DIAL of the 1023 in the upper part of the scale. This gives the necessary voltage to activate the built in sweep integrator. The automatic sweep will then begin when the SWEEP CONTROL on the 1023 is switched to "Ext. Electr."

4. The upper and lower SWEEP LIMITS and the SWEEP SPEED of the 4712 may now be adjusted using its rear panel controls.

3.7. EXTERNAL MODULATION

The 1023 may be frequency modulated by frequencies up to approximately 250 Hz. This is achieved by connection of an external waveform generator to the FREQUENCY CONTROL VOLTAGE "In" socket, pins 6 (+) and 2 (—) (Fig.2.4). The frequency deviation is DC controlled and has a sensitivity of 5 mV/Hz. To give a uniform spectrum, which is especially of importance in acoustic applications, triangle or sawtooth modulation is recommended. For internal modulation, the 1023 uses triangle modulation. Since the circuit is DC sensitive, any arbitrary frequency offset may also be achieved via this connection. A function generator is well suited for external modulation of the 1023.

3.8. DIGITAL OUTPUT

The digital information used by the FREQUENCY DISPLAY of the 1023 may relatively easily be connected to an external device. A 30 pin connector is located beneath the top cover of the 1023 directly behind the FREQUENCY DISPLAY The frequency information is in BCD code and the levels are TTL compatible. The pin designations are given in Table 3.1. Pin numbering is from left to right as viewed from the front of the instrument.

	Digit 1	Digit 2	Digit 3	Digit 4	Digit 5
bit A	5	9	19	26	30
bit B	3	7	17	24	28
bit C	2	6	16	23	27
bit D	4	8	18	25	29
Reset	10	11	15	21	22

Pin 20 = ground 750076

Table 3.1. Connections to the digital output socket.